2000 CALFED Science Conference
Session Notes

Salmonids

Session Chair: Randall Brown
Session Notetaker: Kenneth Lenz

Seasonal feeding habits of steelhead trout in the lower Mokelumne River, California - Joseph Merz, East Bay Municipal Utility District.

Main Issue: Presenter described the results of a study of the feeding behavior of steelhead trout in the Mokelumne River over the two-year study period January 1998-December 1999.

Study Approach:
- study reach covered a 54-km stretch of the Mokelumne River; flows ranged from 1-100 m/sec.
- examined the stomach contents of 179 post-yearling (> 1-year old) steelhead trout.
- calculated an Index of Importance and an Index of Fullness to explain the results of the stomach analyses.

Conclusions:
1. Steelhead feed on a wide variety of organisms, but the typical prey is small organisms (principally invertebrates) of a mean length of 2.5 mm.
2. Steelhead consume substantial amounts of algal material (i.e. algal mats); it is unknown whether they consume the algae for its nutritional value per se or for the associated zooplankton residing in the algae.
3. As their rate of metabolism increases, steelhead consume more prey, not larger prey.

Relevance of Study: This study supports the CALFED ERPP Goal 1 for recovery of at-risk species, Priority Group I.
- confirmed that steelhead are primarily drift feeders.
- identified types and sizes of prey organisms.
- identified seasonal composition of steelhead feeding patterns.

Central Valley steelhead: biology, management, and 'new' concepts for recovery - Dennis McEwan, DF&G.

Main Issue: Presenter described the status of steelhead trout in the Central Valley and identified management strategies that must be implemented to reverse the decline of the steelhead populations.

Study Approach:
- literature review of technical and management-related documents.
- described the historic range of steelhead in the Central Valley, which extended from the Pit River drainage in the north to the Kern River drainage in the South.
- estimated the historic population levels in the Central Valley ranged from one to two million adults, less than 50,000 by the 1950's, 20,000 by the 1960's, and 5-6,000 by the 1990's.
- attributes earlier population declines to the loss of habitat, primarily through construction of impassable dams; recent declines are associated with a decline in the quality of the remaining habitat which has remained at a fairly level amount since the 1960's.
- current paradigm in steelhead management is based on invalid characterization of steelhead, which is principally based on migration behavior, run timing and maturation level of the gonads.
- need to replace current paradigm with one which is based on the recognition of:
    - the persistence of steelhead over a wide range of habitat conditions, including north-south range extremes and ephemeral watershed conditions;
    - variations in population structure that indicate steelhead display polymorphic behavior (as opposed to monomorphic) within a given population that allows both anadromous and non-anadromous forms of steelhead to constitute a single interbreeding population; and,
    - the natural process of extirpation followed by recolonization has been skewed toward extirpation due to the presence of impassable barriers.

Conclusions:
1. The use of ephemeral or impermanent habitat by steelhead buffers their extinction risk.
2. Polymorphic steelhead population structure increases the likelihood of population persistence.
3. Steelhead life history is different from that of chinook salmon and the two species must be managed consistent with their life history needs.
4. Steelhead recovery efforts must focus on re-establishing linkages within and between populations by restoring access to the upper reaches of the watersheds

Relevance of Study: This study supports the CALFED ERPP Goal 1 for recovery of at-risk species, Priority Group I.
- identified management strategies to be implemented to restore steelhead populations.

Genetic diversity and structure of chinook salmon populations in the Central Valley of California - Dennis Hedgecock, UC Davis.

Main Issue: Presenter utilized an evaluation of the genetic composition of chinook salmon to characterize the population structure of Central Valley salmon populations, to

determine the impacts of Feather River Hatchery operations on winter-run and fall-run chinook salmon and to identify winter-run chinook in the Sacramento-San Joaquin Delta.

Study Approach:

- typed up to 10 microsatellite markers for 2600 fish in 41 populations of central valley salmonids.
- used principal components analysis to analyze data.
- measured linkage disequilibrium, which is the non-random association of genotype at two different loci, in hatchery and natural populations of salmonids to demonstrate that there was hybridization between fall- and spring-run from Coleman National Fish Hatchery.
- spring-run chinook from the Feather River samples did not display hybridization; no disequilibrium was detected.
- fall-run chinook from the Feather River display some non-fall-run characteristics; an additional 5 loci will be included in future analyses to refine these analyses.
- used mixed stock analysis in evaluation of winter-run in the Delta.
- used a LOD score, which is the ratio of the probability of that genotype occurring in winter run based on the baseline frequency vs. the probability that that genotype will occur in a non-winter-run chinook, to determine the likelihood that a given fish is a winter-run chinook.
- study supported previous genetic divergence work, with one new finding that there is a second lineage of spring-run chinook salmon from Butte Creek the differ from the spring-run chinook in Deer and Mill creeks.
- spring-run chinook lineages in the Central Valley are quite divergent from other spawning populations of chinook salmon, whereas there is a close association between spring-run and fall-run chinook in the Klamath River system.

Conclusions:

1. There are distinctive chinook salmon lineages in the Central Valley that are well worth conserving (i.e. many stocks have not hybridized.)
2. Genetic markers can be used both for mixed stock analysis and for individual fish identification.
3. There is a risk of hybridizing runs through salmon hatchery operations.
4. The Feather River appears to contain only a fall-run lineage, with no evidence of the presence of spring-run chinook.
5. Individual winter-run chinook have been identified in the Delta.
6. The old length-date criteria are invalid for determining take of listed species at the SWP and CVP diversion facilities in the South Delta.

Relevance of Study: This study supports the CALFED ERPP Goal 1 for recovery of at-risk species, Priority Group I.

- genetic analyses can be used to distinguish populations of chinook salmon.

Which loci provide greatest genetic power to discriminate spring-run chinook salmon of California's central valley? - Michael Banks, Bodega Marine Laboratory

Main Issue: Presenter described the results of a study of the power of the analysis of genetic data to distinguish individual candidate spring-run chinook.

Study Approach:

- study used individual-based techniques since these techniques, with sufficient power, provide much more information suitable for management decisions on the protection of listed species.
- WHICHRUN is a computer program that requires baseline allele frequencies for the population under consideration plus genotype information on the individual fish to be classified.
- WHICHRUN asks what is the Hardy-Weinberg frequency for the genotype observed in each of the individual fish in each of the source populations.
- WHICHLOCI is a computer program used in conjunction with WHICHRUN to evaluate the power of the loci.
- the experimental data set used in this study included 53 loci - 22 microsatellites from Dennis Hedgecock's study, one locus from a major histocompatibiltiy study by Phil Hedrick, one locus from a mitochrondial DNA study, and 29 different allozymes from the NMFS Seattle laboratory.
- Banks did live demonstration of the computer programs to determine which loci are most diagnostic for spring-run and which for winter-run chinook, using variable criteria of acceptance.
- demonstrated how to employ LOD scores to distinguish the spawning populations.
- demonstrated how to use principal components analysis to distinguish the populations in analyzing all 53 loci.

Conclusions:

1. We are closing in on unprecedented power of genetic identification of Central Valley spring-run chinook salmon and chinook salmon in general, with 99% correct identification with less than 0.5% error.
2. Prospects for increased efficiency for loci characterization using programs such as WHICHLOCI indicates great promises for resolution of all Central Valley salmonid stocks.

Relevance of Study: This study supports the CALFED ERPP Goal 1 for recovery of at-risk species, Priority Group I.

- genetic analyses can be used to distinguish populations of chinook salmon.

Salmon stock origin as determined by otolith geochemistry in Sacramento and San Joaquin watersheds, California - Peter K. Weber, UC Berkeley.

Main Issue: Presenter described the purpose of this study as an attempt to use otoliths to determine where the fish originated, where is has been and for how much time by relating the chemistry of the fish to specific locations in the watershed.

Study Approach: otoliths are non-vascularized which means the material is not reworked like bone, thus allowing the analysis of deposits on a temporal basis.

- otoliths are calcium carbonate concretions formed in the inner ear of all bony fish.
- elements " such as strontium (Sr) and barium (Ba) that have similar properties and thus follow calcium are known as "bone seeking".
- fish get up to 90% of their calcium from the water; therefore otoliths represent the chemical constituency of the water in which they reside.
- the isotopic form of Sr is a good conservative marker in that it reflects the geologic rock composition in the watershed.
- the ratio of SR-87 to SR-86 in the water can be used to type various watersheds.
- Sr in hatchery food can be taken up by hatchery-produced fish, which confounds the analysis.
- ten sampling sites ranging along the Central Valley were analyzed for trace elements and isotopic composition.
- generally, the lowest otolith Sr isotope ratio values occurred in southern valley sites and the lowest were recorded in northern valley sites; the exception was the American River watershed which had the highest values, reflective of the ancient rocks in the watershed.
- generally, the variability of the otolith Sr isotope ratio was lowest in the smaller watersheds, highest in the larger watersheds.
- the effect of the heterogeneity of the Sr isotope ratio was tested.

Conclusions:

1. There is a strong relationship between the Sr isotopic concentration in the otolith and in the source water.
2. The relationship in Conclusion 1 is compromised by the contribution of the Sr isotope in hatchery feed.
3. The data from the ten sampling sites allow grouping the watersheds into 7 different groupings.
4. Additional refinement of the relationship in Conclusion 1 could occur through the development of additional markers involving stable isotopes; barium and calcium are candidates for further study.

Relevance of Study:
This study supports the CALFED ERPP Goals 1, 2 and 4 which involve management of targeted species.

Spawning habitat restoration in the Stanislaus River - Carl Mesick, Carl Mesick Consultants.

Main Issue: Presenter identified the primary objective of this investigation was why in some cases restoration salmon spawning gravel needs 3-5 years to "season" before salmon will spawn on the gravel.

Study Approach:
- study was conducted on the Stanislaus River from Two Mile Bar (about two miles downriver from Goodwin Dam) downriver to Oakdale.
- thirteen thousand tons of gravel was added to 18 sites.
- three different types of gravel were used at each of 6 sites.
- the three different gravel types follow:
  Tuolumne River-origin, 3/8 – 5 inches along narrow diameter.
  Stanislaus River-origin, 3/8 – 5 inches along narrow diameter.
  Stanislaus River –origin, ¼ - 5 inches along narrow diameter.
  no cracked rock was used.
- developed maps of the sites with salmon spawning locations identified.
- dissolved oxygen levels and the permeability increased at sites that received salmon spawning gravel.
- salmon spawned in greater concentration in areas that received restoration gravel compared to densities prior to the placement of the gravel.
- statistical analyses indicated there was higher use of gravel that was graded down to ¼ inch than gravel graded down only to 3/8 inch.
- statistical analyses indicated there was higher spawning use of Stanislaus-origin gravel than of Tuolumne-origin gravel.

Conclusions:
1. Chinook salmon spawn immediately in native gravel whereas most avoid imported rock.
7. More spawners use native gravel cleaned with a ¼-inch screen and a 5-inch grizzly compared to gravel cleaned with larger screens immediately after placement.
8. Spawner use will be highest at riffles constructed in upstream areas that are shaped like the tail of a pool.
9. The useful life of the project can be extended by selecting sites where gravel is naturally deposited, i.e. upstream of hydraulic controls.

Relevance of Study:
This study supports the CALFED ERPP Goal 1 for recovery of at-risk species, Priority Group I.
- Identified criteria for the placement of salmon spawning gravel.

Relative abundance of juvenile chinook salmon in the lower Sacramento and San Joaquin Rivers and Delta - R. Burmester, USF&WS.

Main Issue: Presenter described the purpose of the study as the identification of the relative abundance and timing of the arrival of juvenile chinook salmon in the lower Sacramento and San Joaquin rivers and the Sacramento-San Joaquin Delta.

Study Approach:
- the study was conducted in the lower Sacramento River, the San lower Joaquin River, and the Delta.
- beach seining was conducted in the lower Sacramento River and the North Delta to detect the entry of juvenile salmon into the Delta.
- midwater trawling was conducted at Sacramento and at Mossdale to detect the entry of juvenile salmon into the Delta.
- Midwater trawling was conducted at Chipps Island to detect the emigration of juveniles from the Delta.

Conclusions:
1. Larger late-fall juvenile chinook move rapidly through the system.
2. Survival of fall/spring-run juveniles may be much less in the Delta than for the other races of chinook, probably because the fall/spring –run enter the Delta as fry.
3. Winter-run juvenile chinook salmon arrive in the Delta in two peaks of abundance, suggesting that the juveniles that arrive early reside in the Delta.
4. Fall-run juvenile chinook arrive in two peaks.
5. Most fall/spring run chinook leave the Delta as smolts.
6. These data can be used to help select and time protective management actions in the Delta.

Relevance of Study:
This study supports the CALFED ERPP Goal 1 for recovery of at-risk species, Priority Group I.
- confirmed that sampling can detect the presence, timing and abundance of juvenile chinook salmon.

CALFED salmon restoration projects: are we achieving the ecosystem restoration plan strategic goals and objectives? - Edward Cheslak, Jones and Stokes Associates.

Main Issue: Presenter identified the purpose of this study as an evaluation of the effectiveness of the CALFED-funded projects in meeting the salmon restoration goals and objectives of the CALFED Bay-Delta Program.

Study Approach:
- 268 projects approved to date by CALFED, 138 of these affect salmon.

- characterized the type of salmon-related projects as follows (% of total salmon-related):
    - fish management and hatchery - 7%
    - water quality and acquisition - 4%
    - fish passage and screening - 37%
    - habitat restoration - 40%
    - watershed management - 12%
- fish passage and habitat restoration projects have received `90% of the funds distributed to the 138 salmon-related projects; the remaining category received `10% of the funds.
- Have seen increases and decreases in fish population parameters in various watersheds affected by CALFED restoration activities, but the lack of good performance criteria that is measurable/quantifiable hampers an evaluation of the effectiveness of the activities.
- Displayed maps which depict the locations of the CALFED-funded projects, grouped as per the categories of activities indicated above.
- displayed a conceptual model of chinook salmon life cycle and compared how the CALFED projects complement the various life cycle aspects.
- existing impediments to evaluating the success of the CALFED restoration projects include:
    - tracking of projects and documenting the objectives is difficult;
        - project and proposal numbers are not linked;
        - phased projects receive a new number each year.
    - evidence that funding is based on priorities for species restoration is not provided.
    - effects of restoration actions are currently poorly documented.
- the development of explicit conceptual models for the restoration of the overall Sacramento-San Joaquin system would link specific restoration actions to specific mechanisms and to specific performance measures that can be measured.

Conclusions:

1. Select and implement restoration actions based on the likely increased to alternative species.
2. Assess all restoration activities; ask whether they can achieve specific goals and objectives.
3. Revise the conceptual models so the restoration is based on a cumulative assessment of all the effects of the restoration activities,

Relevance of Study:

This study supports all six of the CALFED ERPP Goals.

- implementation of the recommendations in this study is applicable to all CALFED projects.

A standardized quantitative extinction risk assessment of California's anadromous salmonids - Steven Lindley, National Marine Fisheries Service.

Main Issue: Presenter described this presentation as a discussion of a specific population viability assessment (PVA) model that NMFS will use in the recovery planning process for endangered salmonids in the Central Valley for which NMFS has responsibility.

Study Approach:
- NMFS recovery plans will be regional in scope, will involve multi-species assessments of all listed and candidate species, and will include use of quantitative modeling wherever the data are adequate.
- Central Valley is considered as a region by NMFS.
- PVA models will assess recovery goals.
- PVA shortcomings include inability to estimate parameters with precision, good time series data are needed even for the simplest PVA models, and the predictions (i.e. probability of extinction) have very wide confidence limits.
- described a simple PVA model (by Dennis, et. al) that requires only time series census data; discussed the utility and shortcoming of this model.
- presented the results of a 100-year extinction risk, where winter-run chinook had almost a 100% probability of extinction and Stanislaus River fall-run chinook had a 40% risk, but many populations had broad confidence limits up to 1.0; a 24-year extinction risk analysis had lower probabilities of extinction for all fish at risk.

Conclusions:
1. Need to deal with the uncertainty of the models used in recovery plan analyses; simply incorporating more input data will not necessarily improve the model output.
2. Management actions need to be taken with the recognition of the model uncertainties.

Relevance of Study:
This study supports the CALFED ERPP Goal 1 for recovery of at-risk species, Priority Group I.

Modeling the Sacramento River salmon population: model design and preliminary results -
Wim Kimmerer, SFSU Romberg Tiburon Center

Main Issue: Presenter described the Sacramento River Chinook Model, which was used to evaluate CALFED salmonid restoration actions in the Central Valley.

Study Approach:
- model was developed to support the analyses of alternative actions in the CVPIA, but should be useful in coupling with CALFED actions.
- intended to incorporate new knowledge and new technologies.

- scope originally vs. the entire Sacramento Central Valley basin; current version is limited to the Sacramento River and covers only fall-run chinook.
- is an individual-based model.
- critical modeling issues that need to be addressed include representation of fundamental processes, realism vs. efficiency, and time and space scales.
- when modeling complex processes simplified assumptions need to be made, including an address of complex process, possibly through the development of separate submodel that mimics the behavior in the full model.
- if the modeled process has been observed, relationships can be built from available information.
- if the modeled process has not been or cannot be observed, the model relationships must be inferred.
- offered example of a decision rule based on upstream migration of adult salmon.
- offered example of juvenile chinook movement where the importance of developing a general curve that depicts a relationship that appears reasonable was stressed.
- offered example of a model of juvenile salmon movement based on carrying capacity and daily movement rate that included a stick model of the Sacramento River and the Delta.

Conclusions:
Considering the amount of work put into investigating salmonid biology, it is amazing how little we know.
2. Additional data need to be collected on virtually all processes, including how flow affects salmon redds, how salmon grow and how fast they grow, predation and mortality rates, carrying capacity of the river reaches, how juvenile salmonid use the riverine habitat, and the abundance of young salmon.

Relevance of Study: This study supports the CALFED ERPP Goal 1 for recovery of at-risk species, Priority Group I.
- confirmed that steelhead are primarily drift feeders.
- identified types and sizes of prey organisms.
- identified seasonal composition of steelhead feeding patterns.